Picture this SELFI: A Maturation for a Submillimeter Enceladus Life Finder Instrument (SELFI)

Completed Technology Project (2017 - 2020)

Project Introduction

GOALS AND OBJECTIVES In this proposal we aim to develop a flexible and power efficient spectrometer for the Submillimeter Enceladus Life Finder Instrument (SELFI). SELFI is a passive remote sensing submillimeter heterodyne receiver, and upgraded version to both the Microwave Instrument for Rosetta Orbiter (MIRO) and the Submillimeter Wave Instrument (SWI), with the latter currently under development for the Jupiter Icy Moon Explorer. We will take advantage of new digital processing capabilities in order to provide a more flexible and power efficient backend processor than those flown on MIRO or planned for SWI. Current digital back-ends for ground-based millimeter-wave astronomy are able to analyze wideband signals, while offering a flexible range of spectral resolutions. These back-ends are based on high-speed analog-to-digital converters (ADCs) and high-density field-programmable gate arrays (FPGA) devices. The present sampling rate of the ADCs and the computing power of the FPGAs make it possible to directly digitize analog signals of a few GHz of instantaneous bandwidth, and later to analyze them at high spectral resolutions up to a few tens of kHz. METHODOLOGY/DEVELOPMENT Under this instrument maturation project, we propose to advance the SELFI system design to meet the requirements for a planetary mission to Enceladus in order to 1) investigate the composition, abundance, thermal structure, and transport within the plumes, and 2) characterize the source region and processes from which the plumes emerge. In order to accomplish these mission science objectives, we will design SELFI with high spectral resolving power (>107) and equip the instrument with multiple continuum channels (polarized detectors), enabling detection of thermal emissions as cold as 10K, and providing high dynamical range to allow for Enceladus to be mapped throughout its 30–250K temperature range. Emphasis will be placed on maturing the RF-to-digital electronics by designing and building an engineering model that optimizes spectral sampling and radiometric resolution while minimizing dissipated power. Laboratory characterization and environmental testing will mature key instrument subsystems from TRL 4 to 6. RELEVANCE SELFI will be an essential part of any Mission to Enceladus, especially for a plume-sampling fly-by mission and provides numerous compelling science and mission-enabling capabilities. For example, it will provide global observations of Enceladus' active regions and plumes Before, During, and After plume encounter, which can then be used as Mission Operational input by an in situ sampling Mass Spectrometer Instrument (MSI). SELFI Plume Science Objectives are highly complementary to an in situ MSI. SELFI can provide definitive identification for molecular species in a global context, even when observing through dust and/or ice, due to its resolving power >107. SELFI has high sensitivity and will be able to detect many trace molecular species which are biomarkers.

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Maturation of Instruments for Solar System Exploration

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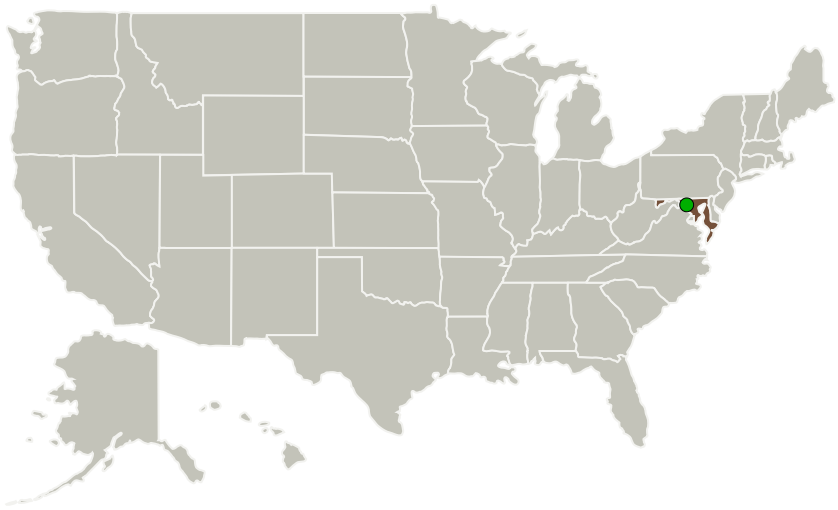
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Project Management

Program Director:
Carolyn R Mercer

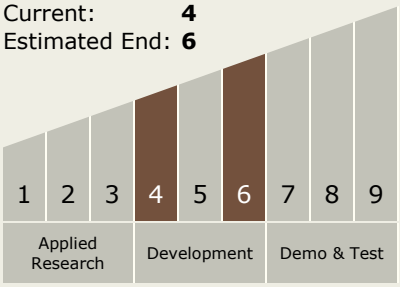
Program Manager:
Haris Riris

Principal Investigator:
Gordon Chin

Co-Investigators:
Timothy A Livengood
Terry A Hurford
Carrie M Anderson
David T Leisawitz
Paul E Racette
Tilak Hewagama

Technology Maturity (TRL)

Start: **4**
Current: **4**
Estimated End: **6**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors

Continued on following page.

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Technology Areas *(cont.)*

- TX08.1.1 Detectors and Focal Planes

Target Destination

Others Inside the Solar System